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CONDENSER DIELECTRIC MATERIAL

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The present invention relates to solid condens-
er dielectric material, and more particularly to
an improved condenser dielectric material com-
prising titanium dioxide heat treated at a cal-
cination temperature.

The capacity of a condenser, as is well known,
is directly proportional to the area of its plates,
inversely proportional to the distance separating
them, and directly proportional to the dielectric
constant of the material between the plates. By
the use of dielectric material having a high di-
electric constant it is possible to increase the
electrical size of the condenser and at the same
time maintain the advantage of small physical
dimensions. The dielectric material to be used
must necessarily have a low electrical loss or
power factor.

Heretofore, condensers also known as capaci-
tors, have been made with dielectric materials
such as paper saturated with various solid or
liquid organic materials. To improve the dielec-
tric properties of the condenser, mixtures of or-
ganic liquids and inorganic powders have been
proposed. In Patent 1,769,874—Boyer, for ex-
ample, the use of titanium oxide powder satu-
rated with nitrobenzene is suggested.

Although the condenser dielectric materials
previously proposed may be used to advantage
for certain electrical applications, the need for a
still further improved solid condenser dielectric
material possessing a high dielectric constant
and low power factor has long been recognized
in the electrical industry.

It is accordingly a principal object of my in-
vention to provide a condenser dielectric mate-
rial having a high dielectric constant and a low
power factor.

The commercial titanium dioxide (TiO₂), ob-
tained by purification of rutile, is unsuited for
condenser dielectric material as it possesses a
low dielectric constant and a high power factor.
This commercial product is white in color and is
an amorphous powder.

I have discovered that an inorganic substance
consisting of titanium dioxide which has been
heat-treated or calcined may be used advanta-
geously for condenser dielectric material. During
the heat treatment some crystals of titanium
dioxide are formed, the material changes from
a white to a bluish grey, then to a light straw
color, and the dielectric constant increases and
the power factor decreases in value.

In accordance with my invention commercial
titanium dioxide is mixed, for example, in a
dough or putty mixer with a small amount, say,

about 1% of a binder that may consist, for ex-
ample, of 1% starch, 1% ammonia and 98% wa-
ter. After thorough mixing, the doughy mass is
pressed into cakes about 1 inch thick and 4
inches in diameter. The pressed cakes are
stacked in a crucible composed of any suitable
material such as alundum, and are subjected to
a heat or calcination treatment in a gas fur-
nace for several hours at a high temperature,
for example, about 1350° C. After the cakes are
cooled they are crushed and sifted through a
fine sieve, for example, one of about 300 mesh.
The resulting powder, which is bluish grey in
color, shows upon microscopic examination the
presence of crystalline titanium dioxide.

The heat-treated powder is again mixed with
a binder, pressed into cakes, subjected to a sec-
ond heat treatment at 1350° C. for several hours,
crushed and sifted in manner similar to that
followed in the initial treatment of the commer-
cial titanium dioxide. The powder after the sec-
ond firing is light straw in color and upon exam-
ination shows crystals of titanium dioxide of
increased size.

Prolonged heat treatment during the first fir-
ing does not increase the size of the crystals.
Likewise, repeated heat treatments of the powder
after the second firing do not increase the size
of the crystals.

The following table shows the dielectric con-
stants and power factors of commercial titanium
dioxide, of commercial titanium dioxide after
one firing and of commercial titanium dioxide
after two firings. The electrical tests were made
by molding the powders with 10% shellac in
discs 1/8 inch thick and 4 inches in diameter and
measuring the electrical characteristics at 1000
cycles.

Material	Color	Dielectric constant	Power factor
Commercial TiO ₂	White	6-12	12-16
Commercial TiO ₂ , fired once at 1350° C.	Bluish grey	15-22	6-8
Commercial TiO ₂ fired twice at 1350° C.	Light straw	22-40	2-3

Various methods of using the heat-treated
titanium dioxide may be employed. For exam-
ple, 5% to 10% of the fired powder may be in-
corporated into paper at the time the paper is
being made. Dielectric sheets may also be pre-
pared by compounding the fired powder with
synthetic resinous compositions such, for exam-
ple, as alkyl resins.

The alkyd resins, as is well known, comprise those complexes resulting from the interaction of a polyhydric alcohol, such as glycerine, and a polybasic acid, such as phthalic acid or its anhydride, with or without other reacting ingredients. A condenser dielectric sheet may be prepared, for example, by compounding flexible alkyd resin compositions, described in Klenle and Rohlf's Patent No. 1,897,260, with about 80% fired titanium dioxide. The resin and the powder are thoroughly mixed, rolled in the usual manner into a thin sheet, for instance, a sheet 0.015 inch in thickness, pressed and cured. Other materials such as synthetic rubbers sold on the market under the trade names of Du Prene and Thiokol, or plasticized polymerized vinyl chloride, may be used in place of the alkyd resin.

Although I have given specific examples for the incorporation of the heat treated titanium dioxide into dielectric sheets I do not wish to be limited thereto. My improved dielectric material is suitable for all types of application where a solid material combining a high dielectric constant and low power factor is desired.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A condenser dielectric comprising an inorganic substance consisting of calcined titanium dioxide of such electrical characteristics that when mixed with 10 per cent shellac and molded into a disc $\frac{1}{8}$ inch thick and 4 inches in diameter and its electrical properties measured at 1000 cycles, such disc possesses a power factor of not more than 3 and a dielectric constant of at least 22.

2. A dielectric material comprising an inorganic substance consisting of titanium dioxide

calcined at a temperature of at least about 1350° C.

3. A condenser dielectric comprising at least 5 per cent of an inorganic substance consisting of titanium dioxide calcined at a temperature of at least about 1350° C.

4. A dielectric material comprising a sheet of resinous material containing about 80 per cent of an inorganic substance consisting of titanium dioxide calcined at a temperature of at least about 1350° C.

5. A condenser dielectric comprising a sheet of flexible alkyd resin containing about 80 per cent of an inorganic substance consisting of titanium dioxide calcined at a temperature of at least about 1350° C.

6. A condenser dielectric comprising an inorganic substance consisting of the resultant of subjecting titanium dioxide to two successive calcination treatments at a temperature of approximately 1350° C.

7. A condenser dielectric comprising an inorganic substance consisting of the resultant of subjecting titanium dioxide to at least two calcination treatments at approximately 1350° C.

8. A dielectric material comprising a dielectric sheet material having incorporated therein an inorganic substance consisting substantially of crystalline titanium dioxide produced by calcining amorphous titanium dioxide at a temperature of at least about 1350° C.

9. A dielectric material comprising paper having incorporated therein an inorganic substance consisting substantially of crystalline titanium dioxide produced by calcining amorphous titanium dioxide at a temperature of at least about 1350° C.

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